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THE COLORADO RIVER BASIN

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REPORT ON

THE COLORADO RIVER BASIN

for the

PRESIDENT'S WATER RESOURCES POLICY COMMISSION

Prepared by the

Western Gulf and Colorado Drainage Basins Office
Division of Water Pollution Control

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THE COLORADO RIVER BASIN

PART I

PHYSICAL AND ECONOMIC DATA

Description of the Basin

The Colorado River basin is marked by broad flat rolling valleys, deep canyons and intersecting mountain ranges. The general altitude of the upper portion varies between 5,000 and 9,000 feet with hundreds of peaks over 13,000 feet in altitude and many exceeding 14,000. This river drains an area of approximately 242,000 square miles in the United States and 2,000 square miles in Mexico. The basin varies from 300 miles in width at the upper section to 500 miles in the lower section. Tributaries extend into seven Western States; namely, Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

The population of the basin, including the Salton Sea Basin, was 918,069 according to the 1940 census. The present total population, exclusive of the Salton Sea Basin, is estimated between 1,000,000 and 1,500,000 persons. The population of the basin has increased considerably since World War II. The present population density is 6.2 persons per square mile, compared to a 1940 national average of 44.2 persons per square mile. The basin is sparsely settled, with population concentrations limited to those areas which can be irrigated, mined, or hold special attractions such as railroad or tourist centers.

The basin has extremes of climate ranging from year 'round snow cover and heavy precipitation on the high peaks of the Rockies to semitropical desert in the southern and lower portion. The average annual temperatures range from about 40° at the extreme upper part of the basin to over 70° near the mouth of the river. The larger portion of the basin area is included within the average annual iso-thermal line of 50°. Most of the basin has more than 180 clear days per year. Under such diverse climatic conditions, a marked variation in rainfall occurs. At Wolf Creek Pass, in the very headwaters, the annual precipitation averages 29.84 inches; at Moab, in eastern Utah, 9.58 inches; at the Hoover Dam 4.84; and at Yuma 3.58 inches. In summary, the basin is extremely arid, about 34 per cent of the area with an annual rainfall of less than 10 inches and more than 85 per cent with less than twenty inches.

The stream flows of the Colorado River might be considered in two parts, those flows which occur in the river above Hoover Dam with its impounded Lake Mead and those flows which occur below this gigantic impoundment, where the flow is completely man-regulated. The average annual flows in second feet that appear in the Colorado above Lake Mead vary from 100 in the extreme headwaters to 8,193 as the river leaves the State of Colorado, to 17,350 as the Arizona-Utah border is crossed, to 17,710 at the station above Lake Mead. Below Hoover Dam four stations along the river present records which show a continuous diminution of flow due to irrigation, evaporation and domestic water supply withdrawal. These flows are from 13,960 to 9,153 as the river enters the canal system above Yuma. The average annual flows do not clearly portray the stream flow characteristics for the minimum to extreme maximum for the station above Lake Mead is from 700 second feet to more than 300,000 second feet. The range in flow below Hoover Dam is from 0 to 51,200 during the years since the Dam was constructed.

The "Muddy" Colorado and its tributaries with their turbulence and silt carrying ability may be explained in part by the gradient or profile characteristics of the basin. The gradient between the high lands of the upper basin and the mouth of the river at sea level on the Gulf of California, is extremely steep, particularly until the river and its tributaries pass through an escarpment between a high plateau and the lowlands. Hoover Dam is located at the west end of this escarpment.

On the Colorado River above Hoover Dam, the annual contribution of silt to its reservoir (Lake Mead) is roughly estimated at 27,000,000 tons from the Green River above Green River, Utah; 20,000,000 tons from the Colorado River above Cisco, Utah; 46,000,000 tons from the San Juan River above Bluff, Utah; and 106,000,000 tons from the river and its tributaries below these points and Lake Mead—or a total average contribution of 199,000,000 tons of silt to Lake Mead each year.

The water discharged from Hoover Dam is free of silt but the amount picked up from the river bed below and carried past Yuma, Arizona (near the mouth) averages about 13,000,000 tons annually.

Without further impoundments, the limit of the present developed water supply for irrigation has been reached with 1.7 per cent of the total land area under irrigation. In 1940, there were 39,145 farms in the basin. Agriculture is one of the three major economic resources of the basin.

Industrial development, outside of mining, does not constitute a major economic activity of the basin. Although World War II created a number of new industries in the basin, there were but 8,798 employees engaged in manufacturing in 1939. An extensive portion of the mining area of the United States is included in the basin. A 1941 census of total mining production reported that the lower Colorado River basin produced 34% of the copper, 16% of the silver, 10% of the gold, 5% of the lead and 4% of the zinc. These figures do not include the production of the upper basin. The upper basin produced about 15,000,000 tons of coal during 1943. In addition to the above minerals there are being produced, oils, manganese, molybdenum, fluorspar, and others. The basin supplies practically all of the uranium ore mined in the continental United States.

The basin abounds in attractions to the tourist which creates what is considered as one of the three leading economic activities, that of "tourist trade". Attractions such as the Grand Canyon, Petrified Forest, Bryce Canyon, Zion National Park, Mesa Verde National Park, Hoover Dam, San Xavier Mission, and many other nationally known scenic attractions are the basis for much of this tourist interest. The warm climate in the southern part of the basin draws a heavy "winter trade" to that area.

Due to the arid condition of most of the basin, the dams and other types of man-made reservoirs constitute a focus of interest to the sportsman and other persons interested in out-of-doors activity. Practically all of these many reservoirs are used for bathing, fishing, hunting, camping and similar recreation. The attraction of these impoundments cannot be over emphasized for many of them serve as the only source of recreation to large areas. The water within these man-made reservoirs is vital to the life as well as to the recreation of the people within and adjacent to the basin.

Of the total area in the basin, more than 35% is owned by the Federal Government in the form of Indian Reservations, National Forests, National Parks and Monuments and similar holdings, exclusive of Grazing Districts. This area approximates 85,000 square miles. Only nine states have an area exceeding this figure. The Federal Government is the largest single land owner in the basin.

It might be said, there are four main characteristics of the Colorado River basin that give it unusual hydrological features. (1) The extremely arid climate results in a lack of vegetation to retain water and soil on the watershed. (2) The precipitous gradient of the basin discharges water rapidly. (3) The tremendous range in river flow results in an unreliable supply and compels the

development of the full water resources of the basin to the point that all flow will be subjugated to the desires of man. (4) The tremendous burden of silt which is carried and deposited by the river causes a constantly changing channel, and materially affects the handling of this flow for irrigation and other uses.

As more storage and hydroelectric projects are installed, the Colorado will lose two of its principal characteristics: the wide fluctuations in flow and the silt burden.

As an example to illustrate the need for the control of water within this basin, there was no flow at the mouth of the Gila River during the entire five-year period between August 1941 and August 1946 although this tributary to the Colorado has a drainage area of 53,000 square miles and during this five-year period there were substantial flows in the upstream reaches of this drainage basin.

Source of Pollution

As has been indicated, the principal source of pollution is silt. Silt pollution is found throughout the basin. There also is some pollution due to leaching of salts from irrigated lands. These problems need additional study.

No information is available on sources of industrial pollution although it is known that vegetable processing wastes are dumped into the river at Yuma, Arizona.

The urban population in this basin has a high standard of living. Ninety-two percent of the people use public sewers. Of necessity these sewers discharge to the watercourses of the basin. Roughly half of the pollution load is removed by sewage treatment. Pollution problems that exist are highly localized because of the vast distances existing between population centers and of the unique climatic conditions of the area.

Due to the extreme scarcity of water and the conflict that exists for water as a result of this scarcity, if any pollution adversely affects any water flow, regardless of how localized, corrective measures should be seriously considered. This situation has prompted State Health Departments to require as complete treatment as economic conditions permit. The sewage or waste flow that appears in a river channel may be the only permanent flow that exists and as such it may be utilized as a natural stream. The hazards are self evident.

In summary, the total domestic sewage waste loading of the Colorado River may be summarized from the limited data available as follows:

Amount of Pollution Contributed

Source	Number	Estimated No. of People Served	Pop. Equivalent of Wastes Discharged to Watercourse b/
Municipalities a/	79	445,270	213,860
Industrial Plants	No Quantitative Data		

a/ Includes all sewered communities discharging wastes into the permanently flowing direct tributaries of the Colorado River or to water used for irrigation. (This pollution includes the industrial wastes discharged into municipal sewerage systems.)

b/ In reducing to a common basis certain wastes from industries and municipalities, it is common practice to express the non-similar wastes in terms of a common unit, Population Equivalent.

Water Use and Adequacy of Water for Indicated Uses

It has been said that there is one criteria for water in this watershed, which is that it be wet. With this attitude pollution abatement has received limited public support up to the present time. As the population in this basin increases it will be vital that all wastes be given sufficient treatment to insure that all waters may be re-used safely.

The Colorado River basin is surrounded by other areas where th need for water is just as great, and, as a consequence, a considerable amount of trans-basin diversion has occurred. The amount of water available for exportation is limited.

The principal water use is for irrigation and stock watering. When water rights were established little necessity arose for claiming a portion for municipal use so today most communities depend upon ground water as a source of supply. There is practically no unappropriated usable water today.

Except in a few localized situations the water available is considered suitable for all present uses. Other exceptions include a few locations that are using highly saline "return" or drainage

waters for irrigation. Most official health agencies feel that there is a potential health hazard in using sewage contaminated water in raising crops which may be eaten raw and therefore they do not consider many tributary waters satisfactory for irrigating this type of crops.

Silt has affected water use in that operating costs of irrigation, storage, and treatment works have vastly increased. Elaborate desilting works costing $4,526,000 were built at the head of the All American Canal to reduce the silt menace which previously had been removed at a cost of $700,000 annually. An anticipated saving of $500,000 is expected to be shown by this single installation.

The water resources have been developed to a major extent by small impoundments created through the limited resources of the basin population. Only with the introduction of Federal resources have the large impoundments become possible, such as Hoover Dam, Roosevelt Dam, Davis, Parker, Bartlett, Coolidge and many others. In addition to their utilitarian uses, these impoundments provide scenic and recreational attractions, including bathing, fishing, boating, camping and similar activities. In general, these impoundments are not subject to serious pollution; although some do receive sewage flows from the recreation centers built on the shores. As development increases, this type of pollution will become more severe and require greater control.

Need for Treatment Works

The data collected concerning municipal sewage treatment plants indicate that of 222 communities with populations of 350 or more, 60 require new or improved treatment works to remedy localized situations and 112 require no improvement for the purpose of stream pollution abatement. There are no data immediately available for the remaining 48.

There is need for a thorough study of these communities and the mining industries as well to determine their exact status in relation to present and possible future pollution. The pollution of ground water has been variously reported, but research is required to determine the extent, significance, and possible corrective measures to preserve the ultimate amount of water so vitally needed in this arid region.

A table below summarizes the data made available through the State Water Pollution Control Agencies.

Sewage and Industrial Waste Treatment Plant Requirements

Source (1)	Total No. (2)	Without Treatment			With Treatment			No Project Req'd (9)	No Data (10)
		No. (3)	Treatment Needed (4)	Status Unknown (5)	No. (6)	Improvements Req'd (7)	Status Unknown (8)		
Municipalities	222	30	30	0	32	32	0	112	48
Industrial Plants	No Quantitative Data								

PART II

BENEFITS AND COSTS

Only in rare instances is water quality a factor affecting water use in this area. Anything wet is eagerly sought. The additional cost of using a turbid, or salty water is accepted without question. Court battles have been fought over the rights to untreated sewage.

The right of prior use is accepted in this section of the country. The first water rights were claimed by the farmers for irrigation and stock watering, next industry claimed a portion which left little if any first class water rights for domestic and recreational use. Nevertheless there are a number of water uses demanding little in the way of quantity that are tolerated because of the limited sources of water. These uses are individual water supply, non-supervised swimming, vegetable washing, etc.

Public health authorities, conscious of the demand for water and the widespread use of sewage effluents for irrigation, have pressed for sewage treatment on a preventive rather than a corrective basis. Although little evidence of an adverse public health effect due to using polluted irrigation water has been uncovered to date, there is a potential health hazard which authorities feel justified in removing.

The cost of providing the degree of sewage treatment recommended by the State Water Pollution Control Agencies within the basin is estimated at $5,675,000. Additional sewage treatment can be expected to raise the level of general public health. Some benefit will accrue to vegetable producers when the stigma of sewage pollution is taken from irrigation waters.

The costs and benefits of silt pollution cannot be estimated in the time available.

No information is available on industrial waste treatment costs.

PART III

SPECIFIC POLICY PROBLEMS

No conflict of water uses exists in the Colorado River basin insofar as pollution abatement is concerned. In an area as arid as most of the Colorado basin, other needs for the limited quantities of water available—particularly for irrigation—are far too critical to permit the recognition of dilution as a legitimate method of pollution abatement. Where it can be obtained concurrent with other needs, dilution may be an acceptable use. It cannot, however, compete or conflict with other water uses in the Colorado basin.

The sediment problems of the Colorado basin have been outlined under Part I. The role of silt in this basin can be summarized by the statement that it is, by far, the most important pollutant of the river and one which by sedimentation and channel aggradation greatly increases the cost of flood control and irrigation works. Silt from soil erosion is slowly filling the vital water storage reservoirs and it has already ruined many hundreds of miles of stream for recreational use. Over much of its length, the Colorado carries a maximum silt burden in suspension.

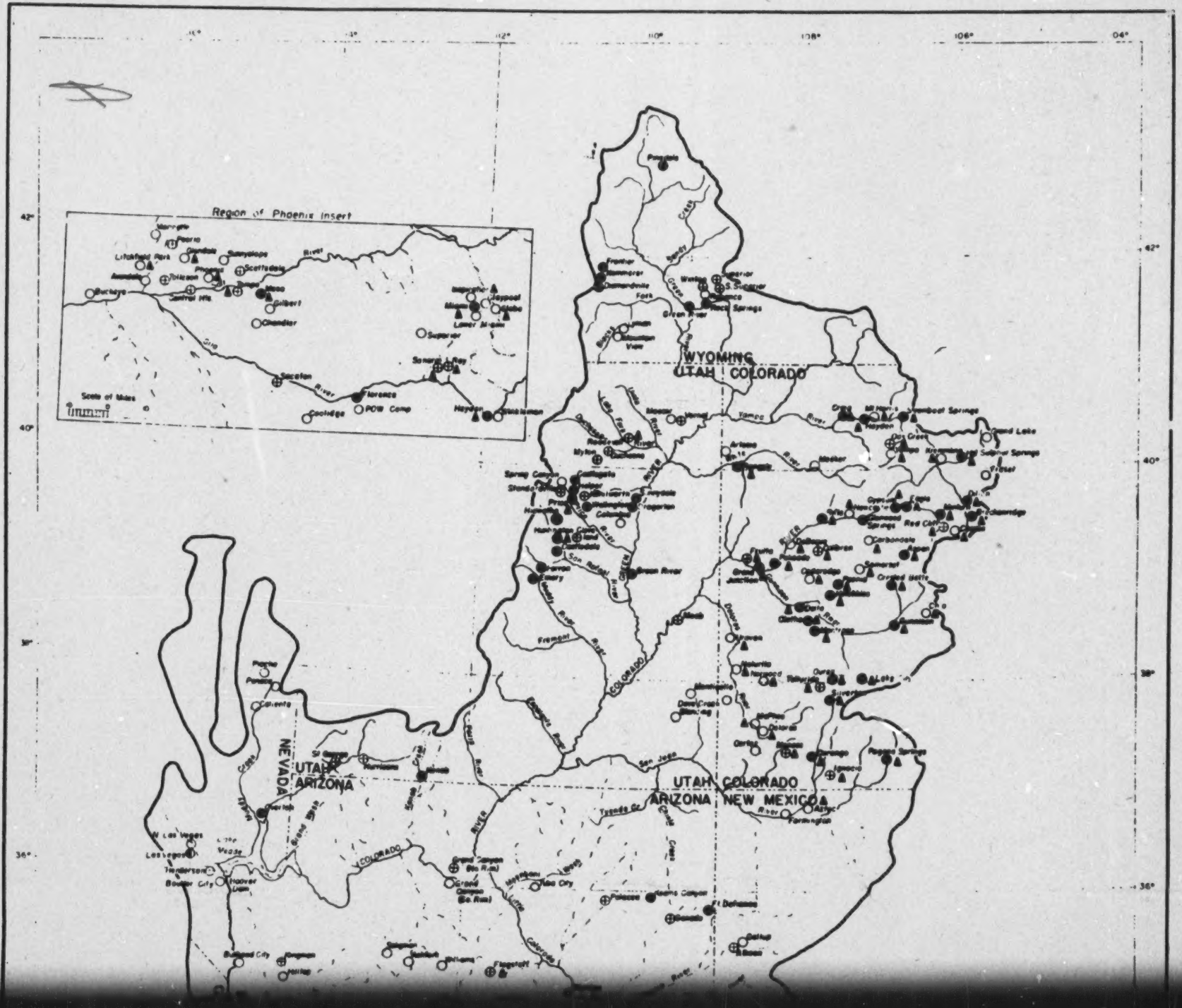
The existing degree of coordination between the various agencies of the Federal Government is satisfactory to resolve problems arising regarding pollution abatement.

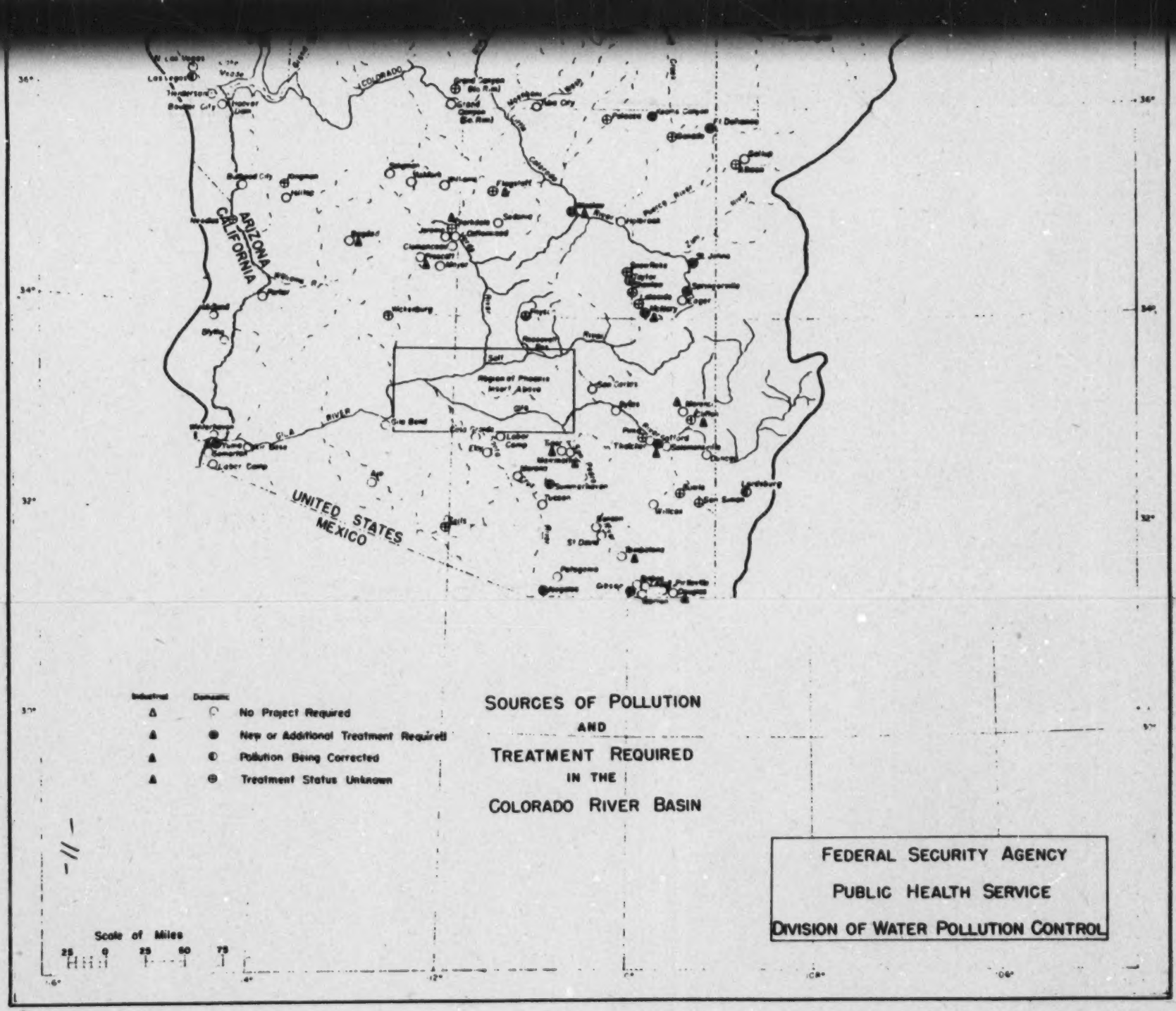
A critical lack of adequate basic data exists which precludes proper planning of the Water Pollution Control Program within the Colorado basin. This dearth of basic data stems, in a large part, from the fact that water pollution is viewed with such minor concern by the States that there have been no funds for, nor interest in sustaining a coordinated program. State water pollution activities are principally confined to routine sanitation and to short-term investigation of complaints—neither of which constitute productive sources of the data required for a comprehensive program of pollution abatement.

The problems of securing local participation in pollution abatement programs center primarily around better agricultural practices to reduce soil erosion and the lack of funds at the community level to build corrective works. In many instances, communities needing sewage treatment facilities already have reached the statutory limits of their bonded indebtedness. The

citizens, facing increased taxes, refuse to vote the special levies required to finance sewage treatment. It is believed that effective public education, supported by factual information upon the needs for pollution abatement in the protection of entire watersheds, might elicit a more favorable reaction from the taxpayers than the customary approach that the needs of each community constitute an individual and isolated problem for solution.

Adequate disposal of the principal industrial wastes of the Colorado basin, namely mine tailings and fruit and vegetable processing offal, has not been attained. This is probably due to the fact that the problem has not been considered sufficiently critical to warrant concerted abatement effort.


Region of Phoenix Insert
WYOMING
UTAH
COLORADO
NEVADA
UTAH
ARIZONA
UTAH
COLORADO
ARIZONA
NEW MEXICO
COLORADO
GREEN
YAMPA
WHITE
SAN JUAN
LITTLE COLORADO
VIRGIN
GILA
Scale of Miles

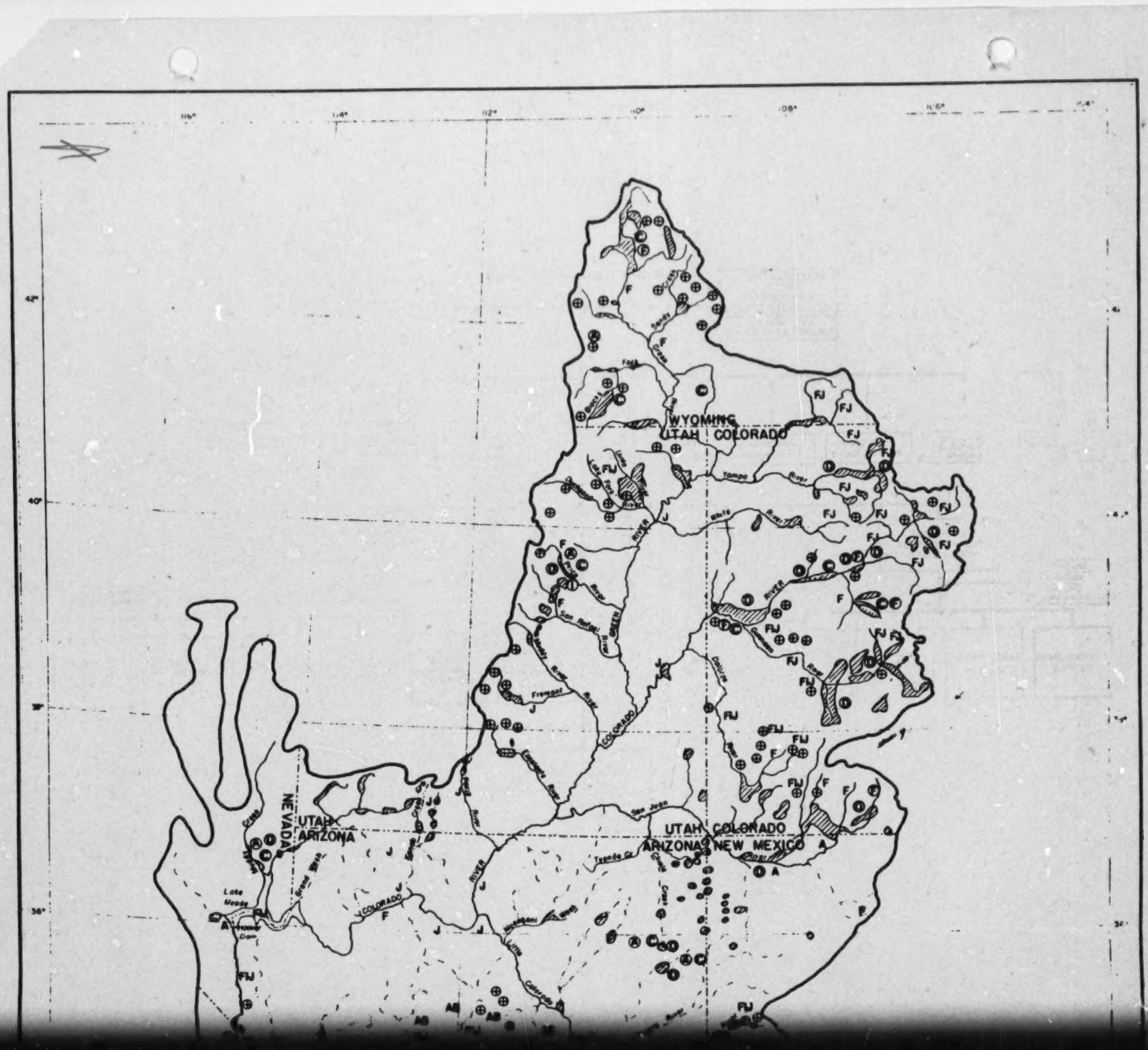


Industrial	Domestic	
△	○	No Project Required
▲	●	New or Additional Treatment Required
▲	◐	Pollution Being Corrected
▲	⊕	Treatment Status Unknown

SOURCES OF POLLUTION AND TREATMENT REQUIRED IN THE COLORADO RIVER BASIN

FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL

GPO 050 17-990


WYOMING
UTAH
COLORADO
NEVADA
UTAH
ARIZONA
UTAH
COLORADO
ARIZONA
NEW MEXICO
COLORADO
RIVER
Lake Mead
Hoover Dam
Green River
San Juan River
Fremont River
Dolores River
Gunnison River
Yampa River
White River
Price River
San Rafael River
Virgin River
Escalante Cr.
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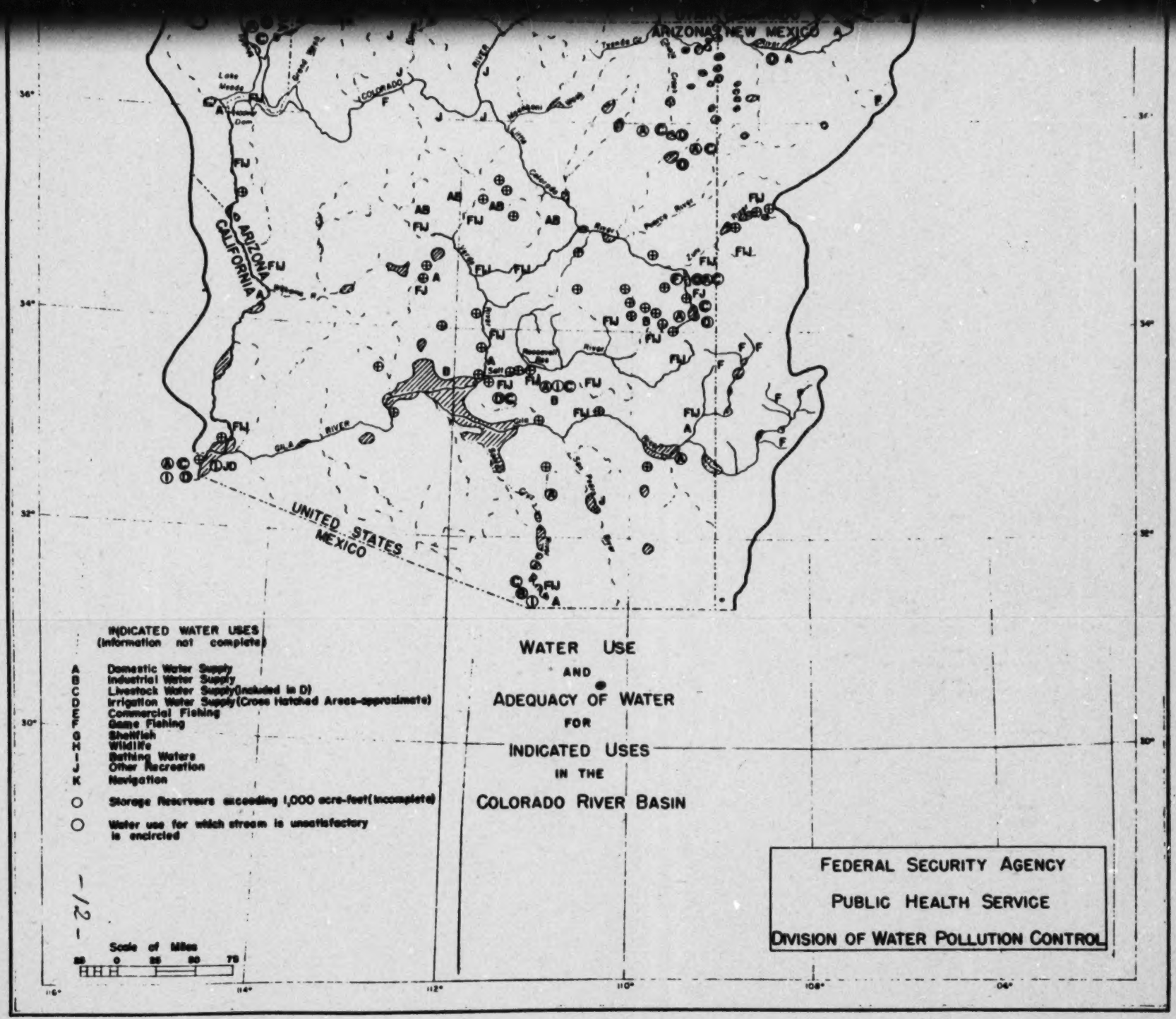

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